Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:	: Examiner: Irina S. Zemel
ARCH, Paul Edward	:
BRESSLER, John Thomas	: Confirmation #4655
BERGHMANS, Michel Floretine Jozef	:
BLEIJENBERG, Karel, Cornelis	: Art Unit: 1711
COWAN, David Allen	:
	: Attorney Docket
U. S. Serial No. 10/021,716	: No.
	: 9220 USA-NONP
Filed: November 30, 2001	:
	:
Foamed Cellular Particles Of	:
An Expandable Polymer Composition	:

DECLARATION UNDER 37 C.F.R. 1.132

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

I, Paul Edward Arch, hereby declares as follows:

1. I am a co-inventor of the invention described and claimed in the above-captioned application.

2. I am currently employed by NOVA Chemicals Inc. in the capacity of Research Fellow.

3. I received a [degrees and institutions and dates degrees received]

December 1999: University of Pittsburgh, Master of Science in Materials Science

December 1987: Drexel University, Master of Science in Chemical Engineering

May 1975: Carnegie Mellon University, Bachelor of Science in Chemical Engineering

5. I am a member of the following professional societies:
Expandable Polystyrene Molders Association (EPSMA - see www.epsmolders.org)
ASTM International ASTM - (see www.astm.org)
Society of Plastics Engineers (SPE - see www.4spe.org)

6. I have worked in the area of expandable polystyrene polymers for the past 24 years. At the time the invention was made I was a Sr. Development Engineer. I am also a named inventor on four U.S. Patents: 4,798,749; 4,853,445; 4,840,759; and 6,908,949.

7. In connection with the above-captioned application, I have carefully studied and reviewed U.S. Patent Application Serial No. 10/021,716, including the amended claims set forth in the attached Amendment; and the Final Office Action dated April 6, 2005, including the Examiner's rejection of Claims 1-26 and 49 as being anticipated by or in the alternative as being obvious over WO 00/15703 to NOVA Chemicals.

8. After reviewing this Final Office Action and the WO 00/15703, it is my well-considered opinion that claims 1, 3-26 and 49 in their amended form are not anticipated by WO 00/15703, and that the particles disclosed in WO 00/15703 are not inherently capable of being expanded to the claimed density in

any conventional equipment at any conventionally used conditions. More specifically, the particles disclosed in WO 00/15703 containing less than 2.0 wt % blowing agent, e.g. pentane, cannot be expanded to form foam articles with a bulk density ranging between about 0.50 pounds per cubic foot (8.0 kilograms per cubic meter) and 6.0 pounds per cubic foot (96.1 kilograms per cubic meter) without further impregnating these particles with an additional amount of blowing agent prior to further expansion/molding of the particles to form the foam articles. The evidence that was generated confirms this position.

9. On June 23, 2005, a work request was issued to perform experimental work in the lab at NOVA Chemicals Inc. in order to generate data to differentiate the inventive particles from the particles of WO 00/15703. From this data, expansion performance would be able to be predicted for the particles of the cited art containing 2.0 percent by weight pentane and for the particles of the invention containing greater than 2.5 percent by weight pentane. In this way, it could be demonstrated that the inventive particles could be processed using conventional equipment, while the particles of the cited art could not be processed using conventional equipment.

10. Between June 23, 2005 and July 22, 2005, pre-nucleated particles, i.e. particles that were previously pre-expanded to less than 3 times its original density, which may represent both the foamed particles of the invention and the particles of WO

00/15703 were aged in a draft oven at approximately 48°C over a period of about 10 to 17 days in order to produce particles with varying pentane levels ranging from 2.07 to 2.68 weight percent. The objective was to then determine the relative expandability of particles at pentane levels of 2.07 percent up to 2.68 weight percent. These particles were then pre-expanded further in a lab scale expander under atmospheric conditions. Exhibit A is an x-y plot of the actual expansion data for bulk density vs. steam time for particles containing 2.07, 2.17, 2.50, and 2.68 percent by weight pentane in the lab scale expander. As can be seen, the curve for the bulk density of the particles containing 2.07 percent by weight pentane is shifted upward to relatively very high bulk densities i.e., to about 16 to 22 pound per cubic feet.

11. The bulk density and steam time for the particles containing the various weight percents pentane in Exhibit A was then used to prepare a Y-hat Interaction Plot Model using a multi-dimensional regression analysis. This was done using Six Sigma software from Air Academy Associates. (See www.airacad.com) Exhibit B illustrates the Y-hat model for the two extremes of pentane content tested, i.e. 2.07 percent by weight and 2.68 percent by weight. In general, a multi-dimensional regression analysis is a statistical tool used to model experimental data and to determine the effects and interactions of various process variables upon a response (the so-called "Y-hat) of interest. In this case, the lab scale expandability, as measured by the final bulk density in pounds per cubic foot, was

modeled as a function of pentane levels and steam time. The lower the bulk density, the lighter the final foam particles, and the better the expandability. For example, from the regression that was created: Assuming that 180 seconds in the lab scale expander is equivalent to a reasonable steam time in a pressurized batch expander on a commercial scale, the regression relates expanded density at 180 seconds steam time to total pentane level. By extrapolating, several additional data points were generated to produce the two curves in Exhibit B. Curve A represents particles containing 2.07 percent by weight pentane (cited art) and Curve B represents particles containing 2.68 weight percent pentane (invention).

12. Exhibit C is a Y-hat surface three-dimensional plot of density and steam time for all the various pentane levels. This plot was also generated via the same multi-dimensional regression analysis used to generate Exhibit B. As can be seen, there is a significant difference in density potential between the particles containing 2.07 percent by weight pentane and the particles containing 2.68 percent by weight pentane. It should be noted that there is not a linear relationship, i.e. direct correlation, between pentane level and achieved bulk density, e.g. at a fixed steam time. For example, at about 180 second steam time, about a 23% reduction in pentane level (from about 2.68% down to 2.07%) gives a much higher reduction in expandability or increase in bulk density of about 73% (from about 3.7 pounds per cubic foot to about 13.8 pounds per cubic foot). This would not be expected or predicted. There is a

"cliff" at which expandability drops off very quickly ("exponentially") as the pentane level is reduced. This is shown in that the three-dimensional plot is curved and not flat.

13. While the particles containing 2.07 percent by weight pentane cannot be expanded to a practical useful density with conventional equipment, the particles equal to or containing greater than 2.5 percent by weight pentane can be used to produce pre-puff at densities useful for some real world applications. That is, the acquired final densities for the particles containing 2.68 weight percent pentane ranged from about 12 pounds per cubic feet to 2.0 pounds per cubic feet over steam times of about 60 to 300 seconds; whereas, the acquired final densities for the particles containing 2.07 weight percent pentane ranged from about 22 pounds per cubic feet to 14 pounds per cubic feet over this same steam time range.

14. As an example of commercially useful polystyrene foams, Exhibit D is literature produced by ASTM entitled "Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation" which on the bottom of page 2 in the last four right hand columns the required density for expandable polystyrene particles ranges from 1.80 to 3.00 pounds per cubic feet. These values represent those densities used in real world applications, whereas the higher densities for the particles of the prior art shown in Exhibits A, B, and C (less than 2.5 weight percent pentane) essentially have no real world applications.

15. The mathematical regression model used to generate Exhibits B and C was:

$$D = 0.0002089(t)^2 - 0.11547(t) - 16.662(p) = 62.354$$

Where D = pre-puff density in pcf

t = steam time in seconds

p = particle pentane level in weight percent

The regression table is shown in Exhibit E. As mentioned herein above, Six Sigma Modeling Techniques were used. There is an excellent fit of data as shown by a correlation coefficient R^2 of 0.9262. This indicates the experimental data are very well fitted by the model developed. A "high" R^2 is an indication of a "good" model, which presents the data well, which can be used to predict performance, e.g. foam expandability, within the region of interest and investigation.

16. Exhibits A, B, and C show that the particles having a weight percent pentane of less than 2.5 produce densities in the range of 22 to 14 pounds per cubic feet which have no real world applications. These particles require that an additional amount of blowing agent be impregnated into the particles and/or that special equipment be used to produce densities that are useful in applications such as packaging, cup, and block. In contrast to this, the particles of the invention contain enough blowing agent such that the lower required densities are readily attained for packaging, cup and/or block applications in conventional equipment.

17. I declare further that all statements made herein of my own knowledge are true and that all

statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Paul Edward Arch

Paul Edward Arch

September 9, 2005

Date

Attachments: Exhibits A-E

Exhibit A
Expansion Data (Steam Time vs. Bulk Density)

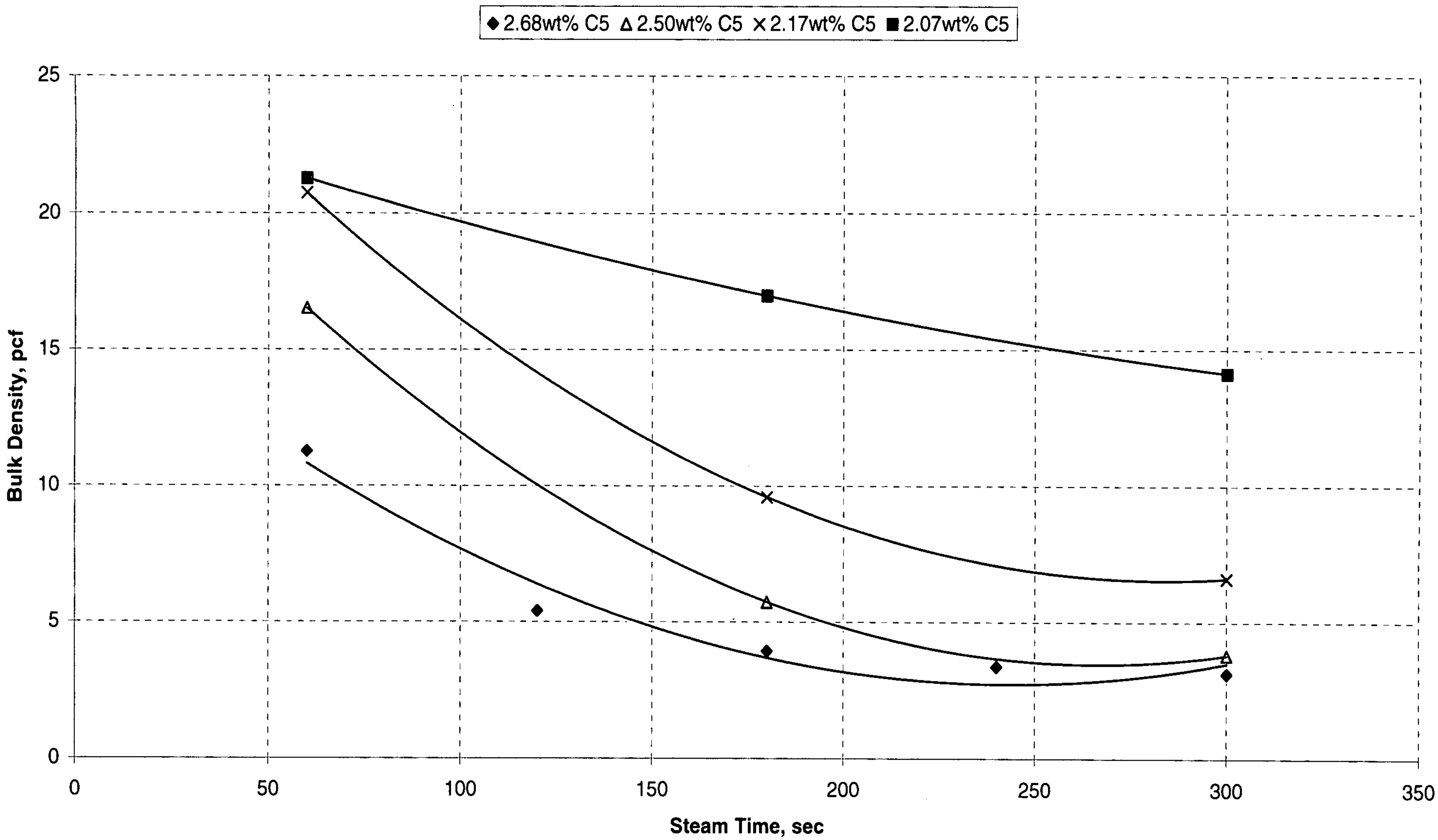


Exhibit B
Y-hat Interaction Plot of (Density, pcf) Time, sec vs C5

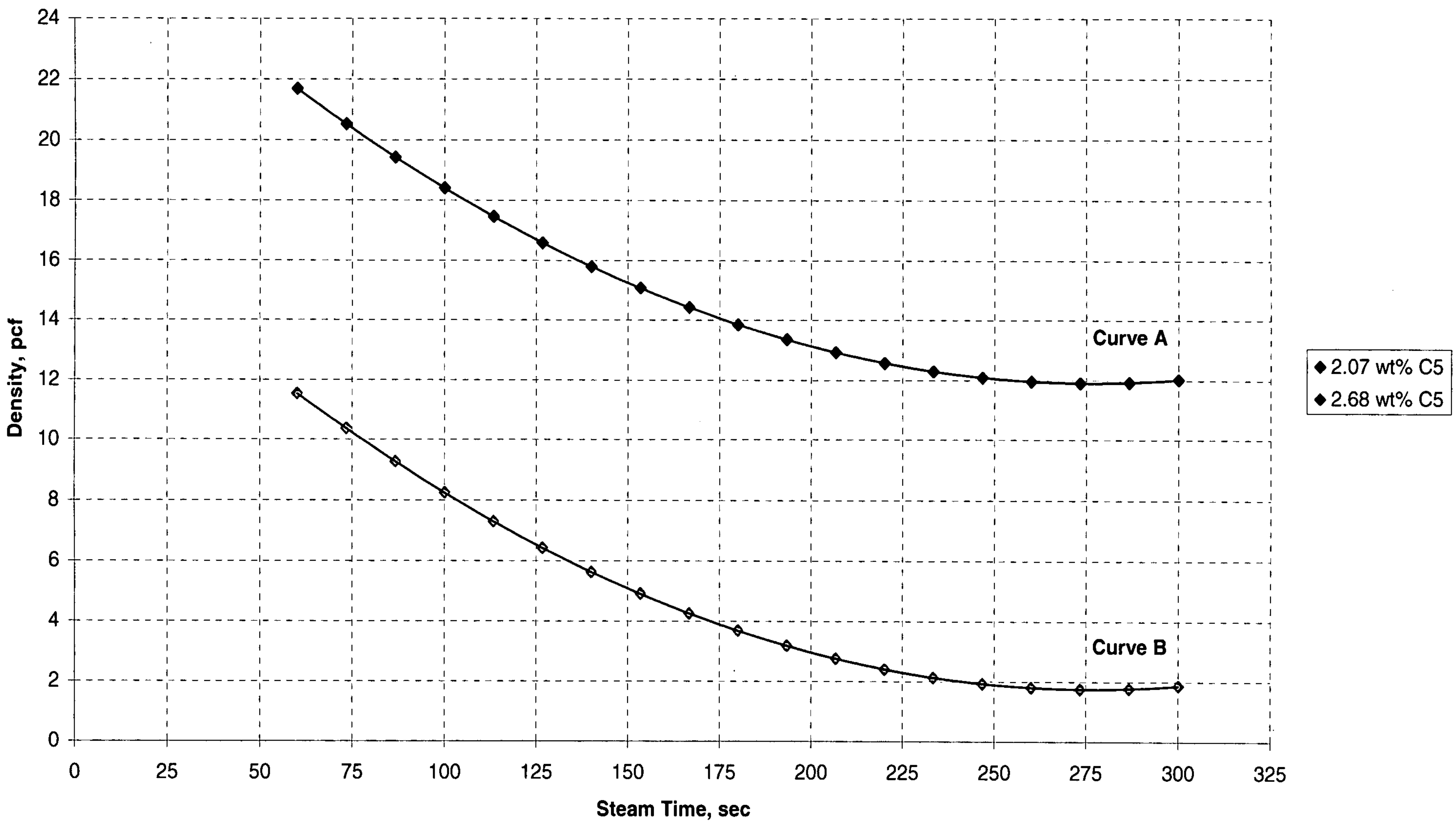
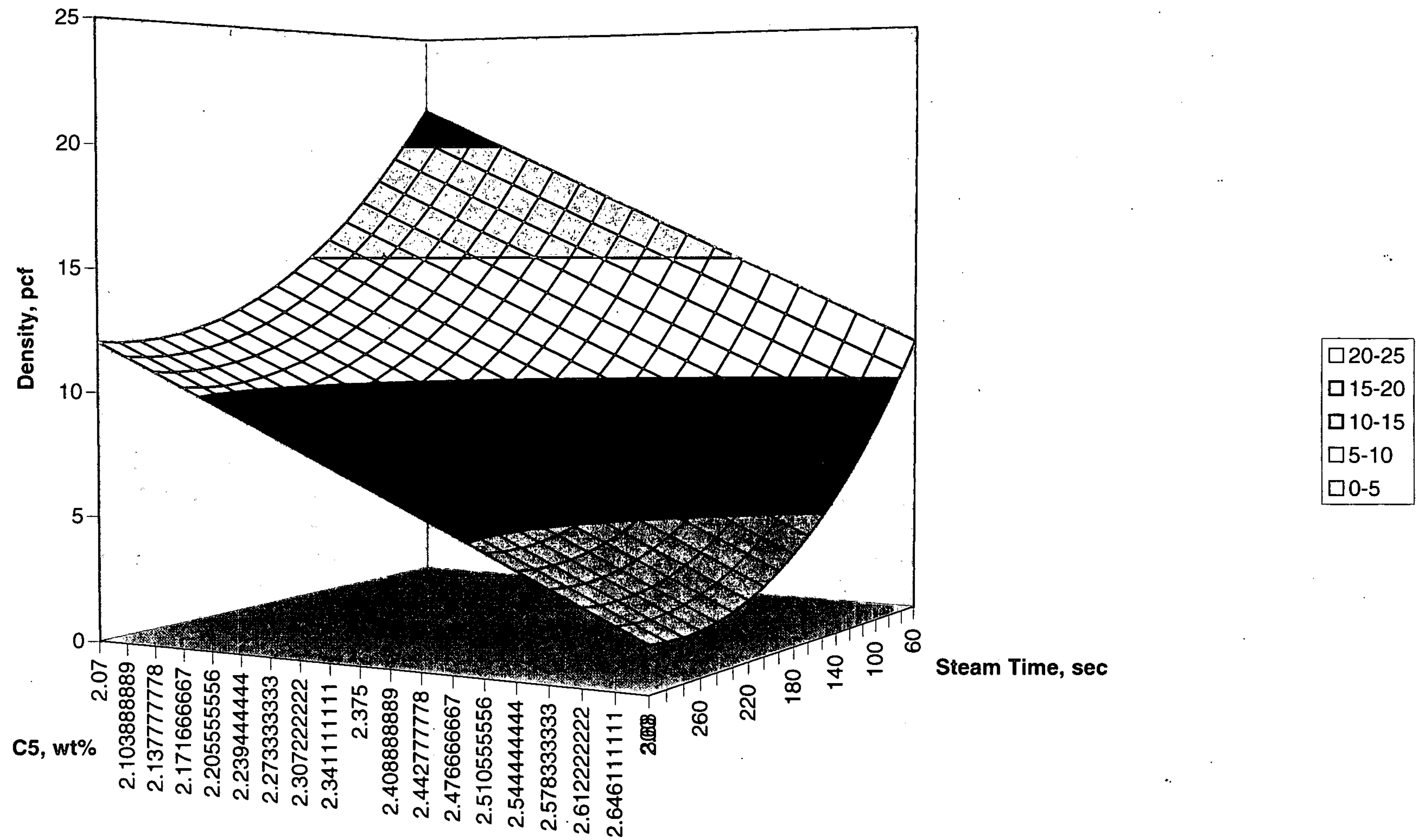


Exhibit C
Y-hat Surface Plot of (Density, pcf) Time, sec vs C5



Designation: C 578 – 05

INTERNATIONAL

Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation[1]

This standard is issued under the fixed designation C 578; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification[2] covers the types, physical properties, and dimensions of cellular polystyrene intended for use as thermal insulation for temperatures from −65 to +165°F (−53.9 to +73.9°C).

1.1.1 For Type XIII only, this specification covers the physical properties, and dimensions of cellular polystyrene intended for use as thermal insulation for temperatures from −297 to +165°F (−183 to +73.9°C).

1.2 Consult the manufacturer for specific recommendations and properties in cryogenic conditions.

1.2.1 This specification does not cover cryogenic properties except for the k-factors for Type XIII in Appendix X1. For Type XIII in specific cryogenic applications, the manufacturer and purchaser shall agree upon the actual temperature limits and physical property requirements in addition to the k-factors in Appendix X1.

1.3 The use of thermal insulation materials covered by this specification may be regulated by building codes that address fire performance. For some end uses, specifiers should also address the effect of moisture. Guidelines regarding these end use considerations are included in Appendix X1.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [3]

C 165 Test Method for Measuring Compressive Properties of Thermal Insulations
C 168 Terminology Relating to Thermal Insulation
C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
C 203 Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation
C 272 Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions
C 303 Test Method for Dimensions and Density of Preformed Block- and Broad-Type Thermal Insulation
C 335 Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation
C 390 Practice for Sampling and Acceptance of Preformed Thermal Insulation Lots
C 518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
C 550 Test Method for Measuring Trueness and Squareness of Rigid Block and Board Thermal Insulation
C 870 Practice for Conditioning of Thermal Insulating Materials
C 1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions
C 1058 Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation
C 1114 Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus
C 1303 Test Method for Estimating the Long-Term Change in the Thermal Resistance of Unfaced Rigid Closed Cell Plastic Foams by Slicing and Scaling Under Controlled Laboratory Conditions
C 1363 Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus

[1] This specification is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C 16.22 on Organic and Nonhomogeneous Inorganic Thermal Insulations.

Current edition approved June 1, 2005. Published June 2005. Originally approved in 1965. Last previous edition approved in 2004 as C 578 – 04a.

[2] This specification is similar to ISO 4898-1984, "Cellular Plastics—Specification for Rigid Cellular Materials Used in the Thermal Insulation of Buildings," in title only. The scope and technical content are significantly different.

ISO standards are available from ANSI, 25 W. 43rd St., 4th Floor, New York, NY 10036.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

D 1600 Terminology for Abbreviated Terms Relating to Plastics
D 1621 Test Method for Compressive Properties of Rigid Cellular Plastics
D 1622 Test Method for Apparent Density of Rigid Cellular Plastics
D 2126 Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
D 2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-like Combustion of Plastics (Oxygen Index)
E 84 Test Method for Surface Burning Characteristics of Building Materials
E 96 Test Methods for Water Vapor Transmission of Materials
E 176 Terminology of Fire Standards

3. Terminology

3.1 *Definitions:*

3.1.1 Terms used in this specification are defined in Terminology C 168.

3.1.2 Terms used in this specification that relate to fire standards are defined in Terminology E 176.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *RCPS*—letter designations for the rigid cellular polystyrene thermal insulation classified by this specification that identifies the product as rigid cellular polystyrene.

3.2.2 *PS*—used in this specification to represent polystyrene in accordance with Terminology D 1600.

4. Classification

4.1 This specification covers types of RCPS thermal insulations currently commercially available as described by the physical property requirements in Table 1.

5. Ordering Information

5.1 Acquisition documents shall specify the following:

5.1.1 Title, number, and year of this specification,

5.1.2 Type (see Table 1),

5.1.3 *R*-value or thickness required (see Tables 1 and 2),

5.1.3.1 *Thermal Resistance/Thickness Relationship*—The thermal resistance (*R*-value) and the thermal resistivity (*R*-value/inch) of RCPS thermal insulation may vary with thickness. Therefore, when ordering, specify the *R*-value or the thickness, or both. For additional information, see Practice C 1045.

5.1.4 Density, if other than specified in Table 1,

5.1.5 Tolerance, if other than specified (see 8.2),

5.1.6 Length and width required (see Table 2 and 8.1),

5.1.7 If other than straight edges are required (see 8.3),

5.1.8 If either ship-lap or tongue-and-groove edges are required (see 8.6),

5.1.9 *Tapered Insulation*—special ordering information. In addition to other applicable requirements in Section 5 (Note 1), acquisition documents for tapered RCPS thermal insulation shall specify the following:

5.1.9.1 Minimum starting thickness,

5.1.9.2 Slope, in./ft (mm/m),

TABLE 1 Physical Property Requirements of RCPS Thermal Insulation

NOTE 1—The values for properties listed in this table may be affected by the presence of a surface skin which is a result of the manufacturing process. The values for Type XIII properties listed in this table must be generated on material with the surface skin removed. Where products are tested with skins-in-place, this condition shall be noted in the test report.

NOTE 2—Type III has been deleted because it is no longer available.

NOTE 3—Classifications are used to cross-reference Fed. Spec. HH-I-524C (see X1.7.1).

NOTE 4—In addition to the thermal resistance values in Table 1, values at mean temperatures of 25 ± 2°F (-4 ± 1°C), 40 ± 2°F (4 ± 1°C), and 110 ± 2°F (43 ± 1°C) are provided in X1.8 for information purposes.

NOTE 5—For Type XIII, in addition to the Thermal resistance property requirements shown in Table 1, there are Apparent Thermal Conductivity property values shown for informational purposes in Table X1.2 of Appendix X1.

Classification	Type XI	Type I	Type VIII	Type XII	Type X	Type II	Type XIII	Type IV	Type IX	Type VI	Type XIV	Type VII	Type V
Compressive resistance at yield or 10 % deformation, whichever occurs first (with skins intact), min, psi (kPa)	5.0 (35)	10.0 (69)	13.0 (90)	15.0 (104)	15.0 (104)	15.0 (104)	20.0 (138)	25.0 (173)	25.0 (173)	40.0 (276)	40.0 (276)	60.0 (414)	100.0 (690)
Thermal resistance of 1.00-in. (25.4-mm) thickness, min, F·ft²·h/Btu (K·m²/W)													
Mean temperature:													
75 ± 2°F (24 ± 1°C)	3.10 (0.55)	3.60 (0.63)	3.80 (0.67)	4.60 (0.81)	5.00 (0.88)	4.00 (0.70)	3.86 (0.68)	5.00 (0.88)	4.20 (0.74)	5.00 (0.88)	4.20 (0.74)	5.00 (0.88)	5.00 (0.88)
Flexural strength, min, psi (kPa)	10.0 (70)	25.0 (173)	30.0 (208)	40.0 (276)	40.0 (276)	35.0 (240)	45.0 (310)	50.0 (345)	50.0 (345)	60.0 (414)	60.0 (414)	75.0 (517)	100.0 (690)
Water vapor permeance of 1.00-in. (25.4-mm) thickness, max, perm (ng/Pa·s·m²)	5.0 (287)	5.0 (287)	3.5 (201)	1.5 (86)	1.5 (86)	3.5 (201)	1.5 (86)	1.1 (63)	2.5 (143)	1.1 (63)	2.5 (143)	1.1 (63)	1.1 (63)
Water absorption by total immersion, max, volume %	4.0	4.0	3.0	0.3	0.3	3.0	0.5	0.3	2.0	0.3	2.0	0.3	0.3
Dimensional stability (change in dimensions), max,%	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Oxygen index, min, volume %	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Density, min, lb/ft³(kg/m³)	0.70 (12)	0.90 (15)	1.15 (18)	1.20 (19)	1.30 (21)	1.35 (22)	1.60 (26)	1.55 (25)	1.80 (29)	1.80 (29)	2.40 (38)	2.20 (35)	3.00 (48)

(25.4-mm) thickness or greater shall be 0.50 ± 0.06 in. (12.7 ± 1.5 mm). For RCPS thermal insulation less than 1.00 in. (25.4 mm) in thickness, the minimum width of the cut shall be 0.25 ± 0.06 in. (6.4 ± 1.5 mm). The ship-lap cut shall be made on opposite faces of the board for both length and width. The resulting joint shall be smooth and uniform.

8.6.2 For RCPS thermal insulation manufactured with tongue-and-groove edges, the tongue of one shall fit snugly into the groove of a second. The resulting joint shall be smooth and uniform.

9. Workmanship, Finish, and Appearance

9.1 *Defects*—RCPS thermal insulation shall have no defects that will adversely affect its service qualities. RCPS thermal insulation shall be of uniform texture and free of foreign inclusions, broken edges and corners, slits, and objectionable odors.

9.2 *Crushing and Depressions*—RCPS thermal insulation shall have no crushed or depressed areas on any surface exceeding 0.13 in. (3.3 mm) in depth on more than 10 % of the total surface area.

9.3 The total number of voids on the board surface shall not exceed an average of 1 per square foot with dimensions larger than 0.13 by 0.13 by 0.13 in. (3.3 by 3.3 by 3.3 mm).

10. Sampling

10.1 Unless otherwise specified in the purchase order or contract, the material shall be sampled in accordance with Practice C 390.

11. Test Methods

11.1 *Conditioning and Aging*:

11.1.1 Samples shall be conditioned as required by the test method to either preconditioned moisture equilibrium or conditioned moisture equilibrium, using procedures defined by Practice C 870. Samples shall be held at equilibrium conditions until they are transferred into the testing equipment. Samples to be used for density test, dimensional stability test, and water vapor transmission test shall be conditioned at 73.4 ± 4°F (23 ± 2°C) and 50 ± 5 % relative humidity for a minimum of 40 h prior to the start of tests. Samples to be used for the compressive resistance test, oxygen index test, water absorption test, flexural strength test, and thermal resistance test shall be conditioned as specified in the applicable test procedure.

11.1.2 RCPS thermal insulations that incorporate a blowing agent other than air or pentane shall be aged for either 90 days at 140 ± 2°F (60 ± 1°C) or six months at 73.4 ± 4°F (23 ± 2°C) and 50 ± 5% relative humidity prior to conditioning and thermal resistance testing. Air circulation shall be provided so that all surfaces of the insulation are exposed to the surrounding environmental conditions.

11.1.3 Where boards are tested with skins-in-place, this condition shall be noted in the test report.

11.2 *Dimensions and Density*—Test in accordance with Test Method C 303 or Test Method D 1622.

11.3 *Trueness and Squareness*—Test in accordance with Test Method C 550.

11.4 *Thermal Resistance*—Test in accordance with Test Methods C 177, C 518, C 1114, C 1363 or Practices C 1045 or C 1058. Tests shall be conducted with a temperature differential of 40 ± 2°F (22 ± 1°C). In case of dispute, Test Method C 177 shall be the referee method. The mean temperature for thermal resistance testing shall be 75 ± 2°F (24 ± 1°C).

NOTE 3—Thermal resistance values in Table 1 establish the basis for determining compliance with this specification and are tested under the laboratory conditions specified herein. However, when an estimate of the long term thermal resistance (LTTR) value of a cellular plastic insulation manufactured with a blowing agent (other than air) intended to be retained for a period longer than 180 days is desired, Test Method C 1303 may be used. The LTTR value depends on material thickness. Therefore, when requested by a purchaser and agreed to by the seller, the LTTR value shall be determined and reported for a specific product thickness.

11.4.1 Test Method C 335 may be applicable to insulation used in pipe applications.

11.5 *Compressive Resistance*—Test in accordance with Test Method C 165, Procedure A, at a crosshead speed of 0.1 in./min/in. of thickness (100 mm/min/m), at yield or 10 % deformation, whichever occurs first (with skins intact), or test in accordance with Test Method D 1621. Five Specimens are to be tested. For anisotropic materials (for example, extruded insulation), specimens are to be equally spaced specimens in the cross machine direction of the board. The average compressive resistance for the five specimens tested is to be reported.

11.6 *Flexural Strength*—Test in accordance with Test Methods C 203, Method I, Procedure A. All test specimens shall be 1.00 ± 0.06 in. (25.4 ± 1.5 mm) or less in thickness. For samples less than or equal to 1.00 ± 0.06 in. in thickness (Note 2), cut test specimens from samples keeping both original major surfaces intact. If skins are present on only one major surface, test specimens with that surface in tension. For samples of greater thickness, trim test specimens to 1.00 ± 0.06 in. thickness retaining one original major surface. Specimens shall be tested with the original major surface in tension. For anisotropic products run the tests for both the length and cross directions of the sample. Report the average of these two series of tests as the value for flexural strength.

11.6.1 Specimens less than 1.00 ± 0.06 in. (25.4 ± 1.5 mm) in thickness are capable of continuing to flex without specimen failure (break). In such cases, flexural strength testing shall be performed using thicker specimens and the thickness shall be noted in the test report.

11.7 *Water Vapor Permeance*—Test in accordance with Test Methods E 96, using anhydrous calcium chloride as the desiccant at 73.4 ± 4°F (23 ± 2°C).

11.8 *Water Absorption*—Test in accordance with Test Method C 272. The immersion time shall be 24 h and the test specimens shall be 12 by 12 by 1 in. (305 by 305 by 25 mm).

11.9 *Dimensional Stability*—Test in accordance with Test Method D 2126 for 7 days (168 h) using the following conditions:

Temperature, °F (°C)	Relative Humidity, %
158 ± 4 (70 ± 2)	97 ± 3
−40 ± 6 (−40 ± 3)	ambient

11.10 *Oxygen Index*— Test in accordance with Test Method D 2863.

12. Inspection

12.1 Unless otherwise specified, Practice C 390 shall govern the inspection of material for conformance to inspection requirements. Exceptions to these requirements shall be stated in the purchase contract.

13. Rejection and Rehearing

13.1 Failure to conform to the requirements of this specification shall be cause for rejection. Rejection shall be reported to the producer or supplier promptly and in writing.

13.2 In the case of rejection of a shipment, the producer shall have the right to resubmit the lot for inspection after the removal and replacement of that portion not conforming to requirements.

14. Certification

14.1 Unless otherwise specified in the purchase order or contract, Practice C 390 shall be the basis for the certification. When specified in the purchase order or contract, a report of the test results shall be furnished.

15. Product Marking

15.1 The following shall be marked on each shipping container, bundle, or board:

15.1.1 Insulation specification number.

15.1.2 Type,

15.1.3 Manufacturer's name or trademark, and

15.1.4 Thermal Properties

15.1.4.1 R-value for all Types except XIII

15.1.4.2 k-factor for Type XIII.

15.1.5 Instructions governing the *R*-value at 75°F (23.9°C) mean temperature for the thermal insulation thickness supplied, as follows: *R* means the resistance to heat flow; the higher the value, the greater the insulation power. This insulation must be installed properly to get the marked *R*-value. Follow the manufacturer's instructions carefully. If a manufacturer's fact sheet is not provided with the material shipment, request this and review it carefully.

15.1.5.1 For Type XIII, instructions governing the k-factor at 75°F (23.9°C) mean temperature for the thermal insulation thickness supplied, as follows: k means the apparent thermal conductivity; the lower the value, the greater the insulation power. This insulation must be installed properly to get the marked k-factor. Follow the manufacturer's instructions carefully. A manufacturer's fact sheet is not required for Type XIII.

16. Keywords

16.1 block/board; cellular polystyrene; foam plastic; polystyrene; RCPS; rigid cellular polystyrene; thermal insulation

APPENDIX

(Nonmandatory Information)

X1. END-USE CONSIDERATIONS

X1.1 Combustibility Characteristics

X1.1.1 The fire performance of the material should be addressed through standard end-use fire test methods established by the appropriate governing documents.

X1.2 Test Method E 84/UBC Standard No. 8-1/UL 723

X1.2.1 These tests do not define the hazard that may be presented by RCPS thermal insulation under actual fire conditions. It is retained for reference in this specification as laboratory test data required by some building codes.

X1.3 Water Vapor Transmission

X1.3.1 Most thermal insulations function where there is both a temperature and moisture vapor pressure differential across the insulation. The water vapor permeability of RCPS thermal insulation may be a significant element to be considered when developing the specification for the vapor retarder component of the thermal package for a specific end use condition.

X1.4 Water Absorption

X1.4.1 This characteristic may have significance when this specification is used to purchase material for end uses requiring extended exposure to water. The water absorption of thermal insulations is an important property to the degree that significant content can degrade thermal performance.

X1.5 Freeze/Thaw Exposure

X1.5.1 RCPS insulating boardstock is sometimes used in applications that may subject the insulation to various types of freeze/thaw exposure conditions. These conditions may vary significantly in service. Exposure conditions to be considered include actual temperatures, liquid water availability, and freeze/thaw cycle frequency and duration. Boardstock integrity, as well as thermal/physical property retention may be affected by actual end-use conditions. Consult the manufacturer for specific product, insulation system, and application recommendations.

X1.6 Apparent Thermal Conductivity Values for Type XIII

X1.6.1 Apparent Thermal Conductivity (k-factor) is the inverse of the thermal resistance (R-value) of a 1-inch thick specimen.

X1.6.2 Determine in accordance with Sections 11.1 and 11.4 but report Apparent Thermal Conductivity (k-factor) rather than Thermal Resistance. The thickness of the specimen shall be 1 inch (25.4 mm) for both the aging described in Section 11.1 and the testing described in Section 11.4.

X1.6.3 For Type XIII, the mean apparent thermal conductivity of the material tested shall not be greater than the maximum value identified in Table X1.1. The apparent thermal

conductivity of individual specimens tested shall not be greater than 110 % of the maximum value identified in Table X1.1.

X1.7 Specification C 578/HH-I-524C Cross Reference

X1.7.1 Federal Specification HH-I-524C was cancelled on Jan. 17, 1985. For the convenience of specifiers who may have contracts written in terms of HH-I-524C, the following is a cross-reference table. The letters N\A indicate that the type designation has been deleted because products meeting the requirements are no longer available.

HH-I-524C Type Designation	Specification C 578 Type Designation
I	I
II	II
III	N\A
IV	IV
V	V

X1.7.2 Additional type designations have been established since the cancellation of HH-I-524C to better define the variety of RCPS thermal insulations available.

X1.8 Thermal Resistance Values at Additional Mean Temperatures

X1.8.1 *Thermal Resistance*—The thermal resistance values below are provided for information purposes in addition to the thermal resistance values at a mean temperature of 75 ± 2°F (24 ± 1°C) provided in Table 1 of this standard.

TABLE X1.1 Type XIII, Apparent Thermal Conductivity

PROPERTY	Type XIII
Apparent Thermal Conductivity, max. BTU-in/hr-ft²-°F (W/m-°C)	
Mean Temperature:	
110°F (43.3°C)	0.277 (0.040)
100°F (37.7°C)	0.272 (0.039)
75°F (23.9°C)	0.259 (0.037)
50°F (10.0°C)	0.246 (0.035)
40°F (4.4°C)	0.241 (0.035)
25°F (−3.9°C)	0.234 (0.034)
0°F (−17.8°C)	0.221 (0.032)
−25°F (−31.7°C)	0.212 (0.031)
−50°F (−45.6°C)	0.203 (0.029)
−75°F (−59.4°C)	0.195 (0.028)
−100°F (−73.3°C)	0.181 (0.026)
−150°F (−101.1°C)	0.152 (0.022)
−200°F (−128.9°C)	0.124 (0.018)

TABLE X1.2 Thermal Resistance Values at Additional MeanTemperatures

Property												
Density, min, lb/ft³	0.70	0.90	1.15	1.20	1.30	1.35	1.60	1.80	1.80	2.40	2.20	3.00
(kg/m³)	(12)	(15)	(18)	(19)	(21)	(22)	(26)	(29)	(29)	(38)	(35)	(48)
Thermal resistance of 1.00-in. (25.4-mm) thickness, min, F·ft²·h/Btu (K·m²/W)												
Mean temperature:												
25°F (-3.9°C)	3.45	4.20	4.40	5.20	5.60	4.60	5.60	4.80	5.60	4.80	5.60	5.60
±2°F (±1°C)	(0.61)	(0.74)	(0.77)	(0.92)	(0.99)	(0.81)	(0.99)	(0.84)	(0.99)	(0.84)	(0.99)	(0.99)
40°F (4.4°C)	3.30	4.00	4.20	5.00	5.40	4.40	5.40	4.60	5.40	4.60	5.40	5.40
±2°F (±1°C)	(0.58)	(0.70)	(0.74)	(0.88)	(0.95)	(0.77)	(0.95)	(0.81)	(0.95)	(0.81)	(0.95)	(0.95)
110°F (43.3°C)	2.90	3.25	3.45	4.30	4.6	3.65	4.65	3.85	4.65	3.85	4.65	4.65
±2°F (±1°C)	(0.51)	(0.57)	(0.61)	(0.76)	(0.82)	(0.64)	(0.82)	(0.69)	(0.82)	(0.69)	(0.82)	(0.82)
Classification	Type XI	Type I	Type VIII	Type XII	Type X	Type II	Type IV	Type IX	Type VI	Type XIV	Type VII	Type V

Exhibit E

Regression Table

Y-hat Model		Density, pcf			
Factor	**Name**	**Coeff**	**P(2 Tail)**	**Tol**	**Active**
Const		8.767	0.0000		
A	Time, sec	-4.831	0.0000	1	X
B	C5	-5.082	0.0000	1	X
AA		3.008	0.0059	1	X

C
C

R^2	0.9262
Adj R^2	0.9104
Std Error	1.8533
F	58.5544
Sig F	0.0000
F_{LOF}	NA
Sig F_{LOF}	NA

Source	SS	df	MS
Regression	603.3	3	201.1
Error	48.1	14	3.4
$Error_{Pure}$	NA	0	NA
$Error_{LOF}$	NA	0	NA
Total	651.4	17	